REMARKS

Present Status of the Application

The Office Action rejected all presently-pending claims 1-17. Specifically, the Office Action rejected claims 1, 2 and 5-9 under 35 U.S.C. 102(b), as being anticipated by Ho et al. (U.S. 6,184,138). The Office Action also rejected claims 3 and 4 under 35 U.S.C. 103(a) as being unpatentable over Ho in view of Mandal (U.S. 6,541,367). The Office Action rejected claims 10-14 and 17 under 35 U.S.C. 102(e), as being anticipated by Mandal. The Office Action also rejected claims 15 and 16 under 35 U.S.C. 103(a) as being unpatentable over Mandal in view of Ho. Applicants have amended claims 1, 3-4, 10, 12-13 and canceled claims 2 and 11 to improve clarity. After entry of the foregoing amendments, claims 1, 3-10, and 12-17 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Summary of Applicant's Invention

The Applicant's invention is directed to a gap-filling process. A substrate having a dielectric layer thereon is provided. The dielectric layer has an opening therein. A gap-filling material layer is formed over the dielectric layer and inside the opening. Removing a portion of the gap-filling material from the gap-filling material layer to expose the dielectric layer and conducting a gap-filling material treatment for forming a protective layer on a surface of the gap-filling material layer.

Discussion of Office Action Rejections

The Office Action rejected claims 1, 2 and 5-9 under 35 U.S.C. 102(b), as being anticipated by Ho et al. (U.S. 6,184,138). The Office Action rejected claims 10-14 and 17 under 35 U.S.C. 102(e), as being anticipated by Mandal (U.S. 6,541,367). Applicants respectfully traverse the rejections for at least the reasons set forth below.

The features of the invention are recited in claims 1, and 10. Independent claims 1, 10 recited the features and recites the features as follows:

1. A gap-filling process, comprising the steps of:
providing a substrate having a dielectric layer thereon, wherein the dielectric layer has an opening therein;
forming a gap-filling material layer over the dielectric layer and inside the opening;
removing a portion of the gap-filling material from the gap-filling material layer to expose the dielectric layer; and
conducting a gap-filling material treatment for forming a protective layer on a surface of the gap-filling material layer.

10. A gap-filling process for fabricating a dual damascene structure, comprising the steps of:
providing a substrate;
sequentially forming a protective layer, a first dielectric layer, an etching stop layer, a second dielectric layer and a cap layer over the substrate;
forming a via opening passing through the first dielectric layer, the etching stop layer, the second dielectric layer and the cap layer;
forming a gap-filling material layer over the cap layer and inside the via opening;
removing a portion of the gap-filling material from the gap-filling material layer to expose the cap layer; and
conducting a gap-filling material treatment for forming a protective layer on a surface of the gap-filling material layer.

Ho discloses a method of forming a dual damascene structure comprises forming a barrier layer and a Cu seed layer over the substrate and on the surfaces of the dual damascene opening. Then, filling a material layer such as a spin-on material, SOG or polyimide into the opening. An etching step or a CMP is performed to remove a portion of the material layer. Thereafter, a protective layer is formed over the cap layer. The protective layer is typically deposited over the entire surface of the substrate (col 8, lines 7-12). However, the protective layer of the present invention is formed on the exposed surface of the gap-filling material layer but not over the entire surface of the substrate. Therefore, Ho did not disclose the features of claim 1.

Mandal also discloses a method of forming a dual damascene structure comprises forming a dual damascene opening in a ILD layer and filling a Cu layer into the dual damascene opening. The Cu layer is planarized, and then a capping layer (used as a protective layer) is deposited over the substrate by plasma assisted chemical vapor deposition of silicon oxide, silicon nitride, silicon oxynitride or hrdrogenerated silicon carbide (col. 10, lines 9-12). The protective layer is formed over the entire substrate too. Therefore, Mandal did not disclose the features of claim 10.

The Office Action also rejected claims 3-4, 15-16 under 35 U.S.C. 103(a) as being unpatentable over Ho in view of Mandal.

Although Mandal discloses utilizing plasma assisted chemical vapor deposition to form the protective layer, the method of forming the protective layer of the present invention is

performing a plasma treatment, UV curing or chemical immersion. The plasma treatment is different from the plasma assisted chemical vapor deposition disclosed by Mandal. Further, in the present invention, not only plasma treatment can be used to form the protective layer, the UV curing and the chemical immersion can also be used to form the protective layer. Hence, the features of the invention are neither disclosed nor suggested in the citations.

For at least the foregoing reasons, Applicant respectfully submits that independent claims 1 and 10 patently define over the prior art references, and should be allowed. For at least the same reasons, dependent claims 3-9 and 12-17 patently define over the prior art as well.

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CONCLUSION

For at least the foregoing reasons, it is believed that the pending claims 1, 3-10, and 12-17 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,

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